COMPREHENSION OF RAPID SPEECH BY THE BLIND

PART I

RAY H. BIXLER ET AL

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U.S. Office of Education

Author	: Ray H. Bixler and others
Title	: Comprehension of Rapid Speech Part 1
Pages	: 44
Price	: Photocopy $2.25 Microfilm $2.25

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COMPREHENSION OF RAPID SPEECH BY THE BLIND

Part I

Cooperative Research Project No. 1005

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The research reported herein and originally entitled "Comparative Comprehension by Blind Children of Braille and Recordings at Different Compressions", was supported through the Cooperative Research Program of the Office of Education, United States Department of Health, Education, and Welfare.

Acknowledgements

We were fortunate to have the enthusiastic support of a number of people.

June Morris, Edward Gold, Paul Coates, and Cleves Kederis assisted in the collection of data. Christine Perry, Sherry Penn, and Sara Winges handled the many secretarial details.

The following principals in the Louisville Public Schools assisted us.

1) Mr. Robert B. Clem
   Shawnee High School

2) Miss Minnie Gibbs
   John H. Heywood Elementary School

3) Mr. A.J. Ries
   DuPont Manual High School

Eleven superintendents of schools for the blind provided both facilities and subjects, and met a demanding schedule.

1) Mr. Frank Johns, Jr.
   Oak Hill School for the Blind
   Hartford, Connecticut

2) Mr. Leo J. Flood
   The Illinois Braille and Sight Saving School
   Jacksonville, Illinois

3) Mr. Durward A. Hutchinson
   The Indiana School for the Blind
   Indianapolis, Indiana

4) Dr. Francis N. Andrews
   The Maryland School for the Blind
   Overlea, Maryland

5) Dr. Robert H. Thompson
   Michigan School for the Blind
   Lansing, Michigan

6) George Heltzell
   The Missouri School for the Blind
   St. Louis, Missouri

Acknowledgements (Cont'd)

7) Leland C. Sanborn
The New York State School for the Blind
Batania, New York

8) Egbert N. Peeler
North Carolina School for the Blind and Deaf
Raleigh, North Carolina

9) D.W. Overbeay
Ohio State School for the Blind
Columbus, Ohio

10) Dr. Alton G. Kloss
Western Pennsylvania School for the Blind
Pittsburgh, Pennsylvania

11) E.J. Wood
Tennessee School for the Blind
Nashville, Tennessee

Mr. Gerald R. Smith and Dr. William Carriker served often as consultants.

We are especially indebted to the American Printing House for the Blind for the assistance of recording technicians and the use of facilities.

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The blind child has a marked disadvantage in reading. The median silent visual reading rate for senior high school students is 251 words per minute (Harris, 1947), while the mean Braille reading rate for blind high school students is 90 words per minute (Ethington, 1956). Thus, to cover the same material, the blind child must read almost three hours for every one spent by his sighted peer.

The oral presentation of such material to blind children is frequently appropriate, and its use is increasing. A typical rate for a trained professional reader might be 175 words per minute. Therefore, the blind listener has an advantage over the blind Braille reader, but he still lags considerably behind the sighted reader.

The slow rate of communication to which the blind student is subjected handicaps him on two counts. First of all, he cannot be exposed to as much information as his sighted peer in the time that is available for educational purposes. Thus, he has a reduced opportunity for the elaboration of the network of associations that facilitate transfer of training and thinking in general. Secondly, if the communication rate is slow, the conditions that lead to efficient learning are minimized by the blind student. The slow rate at which he receives information decreases the temporal contiguity of the elements of information to be learned. Close temporal contiguity of the elements to be learned is an important condition for facilitating learning.

A technique, speech compression, is now available that makes it possible to increase the word rate of a previously recorded message without altering other characteristics of the message (Fairbanks, 1954).

Frequently, attempts have been made to increase the auditory communication rate by playing a record, recorded at a given speed, at some faster speed. The result is that the word rate is increased. However, the timbre and pitch of the speaker's voice are radically altered, and intelligibility falls off rapidly. With the speech compression technique, only word rate is changed. The quality of the speaker's voice remains substantially the same. The application of this technique to the communication problems encountered in the education of blind children is obvious. It is now possible to achieve almost any desired word rate. The only limitation is the listener's ability to comprehend what he hears when the word rate is faster than normal. Fairbanks, Guttman, and Myron (1957) have already shown that intelligent adults can comprehend quite well a technical exposition presented at a word rate so fast that listening time is cut in half. The purpose of the present study is to measure the comprehension by blind children as a function of word rate and of the kind of material heard; and to compare comprehension obtained at various word rates with that obtained when the same material is read in Braille.

Method

Experimental Design

A factorial design which varied the type of material presented and the mode of presentation was employed. Two types of material (one scientific and one literary) were presented to the subjects in Braille and at the following auditory word rates: 175 wpm, 225 wpm, 275 wpm, and 325 wpm. In addition, one type was presented at 375 wpm. The original plan was to present both types of material at 375 wpm and

at 425 wpm, but difficulties with instrumentation made it necessary to modify this plan. Following presentation of the materials all groups were tested for comprehension. In order to establish a base line, another group of subjects was tested for comprehension of the scientific and literary material without having been exposed to them.

A separate group of subjects was employed for each mode of presentation. All subjects within a group were exposed to both types of materials. To control for the possibility of a practice effect, the order in which subjects in each group encountered the materials varied. Half of the subjects in each group encountered the literary material first, and half the scientific material. Since subjects were drawn from eleven different schools, there was a possibility that differences among schools might be reflected in the outcome of the experiment. To control for this possibility, the qualified subjects from each school were distributed randomly among all seven conditions of the experiment. Thus, each group of subjects included members from all the schools visited.

Procedure

Subjects were presented the materials and were tested in small groups of three to six.

Three Wollensak tape recorders (Model T1500) and one Norelco tape recorder (Model EL 351G-C15) were used to reproduce the experimental materials. Efforts were made to arrange seating of subjects so that they were as close to the loud speakers of the tape recorders as possible.

First, subjects heard the instructions for participating in the

experiment and taking the comprehension test, followed by the materials to be comprehended. The instructions for those who listened at accelerated word rates included a sample of speech compressed at the rate to which they were to be exposed. (See Appendix A) Immediately following presentation of the auditory materials all subjects were started on the appropriate test of comprehension. Subjects who read the selections in Braille were tested immediately following completion of reading.

All tests were in Braille. The subjects' choice of an alternative for each item was indicated by drawing a pencil mark through the answer he thought was best. Each group was reconvened the following day at approximately the same time and given the other type of material under the same conditions. Those who took the test without having read the material were given instructions orally.

Subjects

291 Braille readers of both sexes in the sixth, seventh, and eighth grades in eleven residential schools for the blind served as subjects. No subjects had previously heard compressed speech. Table I shows the constitution of the groups with respect to institution, grade, and sex. (Page 5)

Experimental Materials

Types of Materials Read -- Materials were chosen from two seventh grade books that were not yet available in Braille. One, "The Yellow Turtleneck Sweater" was taken from Prose and Poetry Adventures, (Iverson, 1957). It is a short fictional account of the tribulations of a young man entering college for the first time. It was chosen because it was felt that it would have high interest value for the

Table I

Schools		Grades						
		6th		7th		8th		
	Sex :	M	F	M	F	M	F	Total
New York		4	9	7	4	8	4	36
Indiana		4	4	2	7	5	4	26
Tennessee		1	5	4	8	2	2	22
Ohio		4	3	5	3	5	4	24
Illinois		3	5	4	4	2	5	23
Maryland		3	5	3	7	6	1	25
Pennsylvania		6	3	4	4	5	4	26
Missouri		6	2	3	2	4	2	19
North Carolina		17	6	7	6	2	4	42
Michigan		6	5	2	5	3	3	24
Connecticut		1	3	2	7	7	4	24
Totals		55	50	43	57	49	37	291

Grade and Sex of Subjects from Schools for the Blind

subjects used in the experiment. The other material, "Your Blood Transports Materials", was taken from a seventh grade science book. (Frazier, 1957) This is a description of the circulatory system and contains a great many technical terms. Reading materials chosen were approximately equal in length and readability. "The Yellow Turtleneck Sweater" contains 2105 words and "Your Blood Transports Materials" contains 2094 words. Both materials are at the fifth and sixth grade level of readability as determined by the Dale-Chall formula for predicting readability. (Dale, 1948) Both were recorded on tape by a professional reader employed in the Talking Book program, and were recorded in the Talking Book studios of the American Printing House for the Blind. These tapes provided the in-put for the device used to accelerate word rate.

For those who read the materials in Braille, Braille booklets were prepared in standard Braille textbook format by the American Printing House for the Blind.

Compression of Materials -- Speech compression is accomplished by periodically discarding a segment of the material to be compressed. The length of the discarded segment is small enough so that no entire speech element is lost. The amount of compression is determined by the frequency with which segments are discarded. This process can be accomplished by at least two commercially available devices. The one used in the present experiment was a Tempo-Regulator manufactured by Telefonbau und Normalzeit, Germany. The materials to be compressed were reproduced on an Ampex Tape Recorder Model 300, and the output of the recorder was applied to the input of the Tempo-Regulator.

The accuracy with which word rates were achieved was gauged by comparing obtained play-back time with expected play-back time at each level of compression used in the experiment. In no instance was the disparity between expected and obtained play-back time greater than ten seconds. In view of the number of processing steps required to arrive at the final tapes used in the experiment, this error is remarkably small.

The Tests of Comprehension -- To test comprehension, a four-alternative multiple-choice test with 36 items was constructed for each of the reading materials. (See Appendix B) Since the steps involved in the construction of each test were the same, the construction of only one test will be described.

Sixty experimental items were given to 99 children from the Louisville Public Schools. Grade distribution of these children was the same as for blind subjects in this study. Sighted children were chosen so as to represent a fairly good socio-economic cross section of the Louisville Public School population. A description of this group is given in Table II.

Table II

Grade and Sex of Subjects from Public Schools

Schools	Grade	Sex		Total
		M	F	
Shawnee	7	17	17	34
Heywood	6	15	19	34
Manual	8	13	18	31
Total		45	54	99

Table III

Test Item	Literature		Science	
	Item Difficulty	Phi Coefficient	Item Difficulty	Phi Coefficient
1	.36	.49	.38	.50
2	.31	.43	.47	.45
3	.77	.41	.16	.30
4	.70	.42	.55	.58
5	.63	.40	.45	.42
6	.80	.41	.72	.35
7	.64	.20	.34	.34
8	.63	.59	.19	.45
9	.79	.41	.40	.26
10	.81	.34	.38	.31
11	.63	.35	.19	.24
12	.65	.22	.38	.40
13	.78	.52	.39	.30
14	.67	.40	.40	.32
15	.56	.44	.52	.59
16	.60	.55	.43	.64
17	.70	.29	.40	.32
18	.80	.57	.77	.30
19	.74	.34	.29	.49
20	.82	.42	.71	.30
21	.55	.65	.19	.31
22	.56	.33	.31	.24
23	.73	.44	.46	.28
24	.70	.39	.57	.54
25	.83	.39	.40	.27
26	.52	.34	.22	.43
27	.65	.67	.51	.38
28	.83	.47	.67	.49
29	.80	.51	.22	.30
30	.78	.34	.40	.23
31	.73	.72	.59	.39
32	.76	.30	.29	.55
33	.72	.59	.30	.32
34	.75	.59	.37	.20
35	.50	.38	.21	.27
36	.76	.20	.43	.47

Item Difficulty and Phi Coefficient Values of Final Test Items from Public School Group

Each child read a mimeographed reproduction of the selection before attempting the test.

Tests were scored and checked, and an item analysis was completed. Two criteria, item difficulty and item-whole test consistency, were employed for elimination of unsatisfactory items. Those items passed by fewer than 15 percent or more than 85 percent of those taking the test were discarded. Any item whose correlation with total test score yielded a phi coefficient of less than .27 was discarded. Twenty-four items failed to meet these criteria resulting in final tests consisting of 36 items. Table III gives the item-difficulties and phi coefficients for the items in the final test forms. (Page 8)

Tests were split on the basis of item difficluty and Pearsonian correlations between halves computed. Split-half reliabilities when corrected by the Spearman-Brown formula were .80 for the literature test and .75 for the science test. These reliabilities were believed acceptable for group measurement.

Results

Table IV gives the means and standard deviations of the comprehension scores obtained by the seven experimental groups.

Table IV

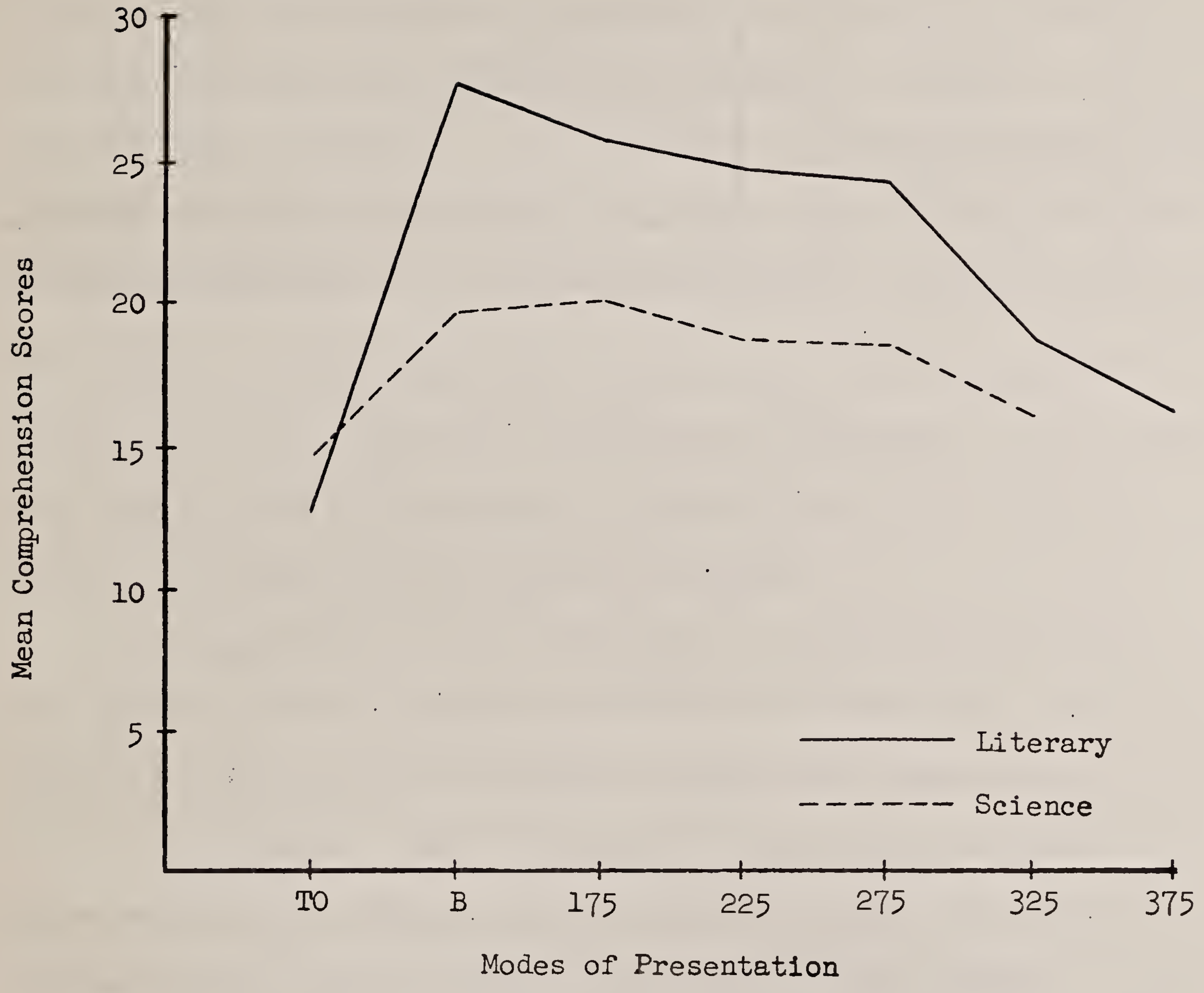
Means and Standard Deviations of Test Scores for the Experimental Groups

Experimental Conditions	Literature			Science		
	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Test Only	40	12.60	3.43	40	14.75	3.96
Braille	42	27.67	6.24	42	19.76	6.99
175	41	25.80	6.53	41	20.12	6.77
225	42	24.74	7.41	42	18.69	6.49
275	42	24.21	6.57	42	18.55	5.64
325	42	18.74	6.28	42	16.17	5.67
375	42	16.24	5.57			

This information is also displayed graphically in Figure 1. (See page 11). The two curves on this graph represent the change in test performance as a function of the change in experimental conditions for the two types of materials to which subjects were exposed. The curve that shows the change in the comprehension of the literary material rises immediately to a high value and falls only slightly up through 275 words per minute. Between 275 and 325 wpm comprehension begins to fall off rapidly. However, even at 375 wpm, there is still some indication of comprehension.

The situation is less dramatic regarding the comprehension of the science material. The curve does not rise to nearly so high a value. However, comprehension of the science material holds up quite well as indicated by the levelness of the curve through 275 wpm. Between 275 and 325 wpm, this curve begins to fall, indicating a decline in

FIGURE 1



Change in Comprehension as a Function of Mode of Presentation

comprehension. The impression conveyed by Figure 1 is confirmed by the results of the analysis of variance shown in Table V.

Table V

Analysis of Variance for All Modes of Presentation

Source	Sum of Squares	DF	Mean Square	F	F(.01)
Between Modes of Presentation	6,013.54	5	1,202.71	20.07	3.10
Between Subjects in Same Mode	14,559.84	243	59.92		
Between Types of Material	2,337.84	1	2,337.84	156.06	6.76
Interaction: Modes X Material	1,310.10	5	262.02	17.49	3.10
Pooled Interaction	3,639.56	243	14.98		

The overall variation among mean comprehension scores obtained at each of the seven experimental conditions is significant. The F-ratio for between modes of presentation as shown in Row 1 of Table V is significant beyond the 1% level of confidence.

The significance of the differences in comprehension for the two types of material used is shown in Row 2 of this Table. The F ratio for between types of material is significant beyond the 1% level of confidence. That the amount of comprehension obtained at a given word rate is dependent upon the type of material heard is indicated in Row 3 of this Table. The F ratio for the modes by types interaction is also significant beyond the 1% level of confidence.

The analysis includes the comprehension test scores of the group that was given the test without having encountered the materials.

The test scores of the "Test Only" group were markedly different from the test scores of those exposed to the materials. There was a possibility that the significant F ratios obtained could be explained by the performance of the "Test Only" groups. To settle this question, the analysis of variance was carried out again, omitting the "Test Only" group. The results of this second analysis are given in Table VI.

Table VI

Analysis of Variance - "Test Only" Mode Omitted

Source	Sum of Squares	DF	Mean Square	F	F(.01)
Between Modes of Presentation	1967.	4	491.75	7.18	3.41
Between Subjects in Same Mode	13,969.38	204	68.48		
Between Types of Material	3,246.98	1	3,246.98	209.75	6.76
Interaction: Modes X Material	308.60	4	77.15	4.98	3.41
Pooled Interaction	3,158.92	204	15.48		

It can be seen that this Table is essentially a restatement of Table V. Differences in the outcome of the experiment related to modes of presentation, types of materials and their interaction were all significant beyond the 1% level of confidence.

Table VII gives the t-ratios for differences in comprehension scores of the seven groups with respect to the literary material. (Page 14) The comprehension of this material achieved by those who listened at 175 wpm was not significantly poorer than that attained by the Braille readers. Comprehension of material heard at 225 wpm was significantly

poorer than that of Braille readers at the 5% level of confidence.

Table VII

"t" Ratio for Differences Among Groups on Literary Material

Rates of Presentation

	Test Only	Braille	175	225	275	325
B	13.46					
175	11.28	1.34				
225	9.41	1.98	.69			
275	9.92	2.49	1.11	.35		
325	5.43	6.57	5.04	4.05	3.94	
375	3.53	----	----	----	5.99	1.92

$t_{.95} = 1.67$
$t_{.99} = 2.38$

Those who listened at 275, 325, and 375 wpm comprehended significantly less than the Braille readers at the 1% level. Statistically significant results may be misleading if other considerations are ignored, (see discussion). The t ratios for the differences in comprehension of the scientific material are shown in Table VIII.

Table VIII

"t" Ratio for Differences Among Groups on Scientific Material

Rates of Presentation

	Test Only	Braille	175	225	275
B	3.98				
175	4.33	.24			
225	3.28	.73	.98		
275	3.52	.87	1.15	.11	
325	1.30	2.58	2.88	1.89	1.93

$t_{.95} = 1.67$
$t_{.99} = 2.38$

The comprehension of this material at word rates up through 275 wpm was not significantly poorer than comprehension achieved by Braille readers. At 325 wpm the loss in comprehension was significant at the 1% level.

In every case except one, the comprehenson of the scientific material was significantly poorer than the comprehension of the literary material. This finding was expected and is attributable, in part to the differences in the types of material. The one exception was shown by those who were tested without having read the material. It is reasonable to assume that the subjects had some prior knowledge of the facts set forth in the scientific material which enabled them to answer some test questions. Since the literary material was fictional, it is unlikely that the subjects could have had much prior knowledge of its content.

Reliabilities for the tests were re-determined, using the scores of those who read the material in Braille. As before, tests were split on the basis of item difficulty, and the resulting halves were correlated using the Pearson-Product Moment r. The Spearman-Brown correction was applied. The coefficient of reliability for the science test was found to be .86 and the coefficient of reliability for the literature test was found to be .91.

Discussion

The outcome of the experiment was encouraging. The comprehension of compressed speech presented at 275 words per minute was nearly as good as the comprehension of material presented in Braille or orally at 175 wpm. This finding is of interest for

several reasons.

The subjects were children. Children do not have as elaborate a background of associations as adults to assist them in the interpretation of material that is difficult to understand. Furthermore, the children who served as subjects in this experiment were hearing material presented in this manner for the first time. It is reasonable to expect that if subjects were given practice in listening to material presented at accelerated word rates, they would have comprehended the two types of material better than did children in the present study.

It is quite likely that if the children who served as subjects had encountered the reading materials used in this study in the normal course of their education, these materials would have been presented in Braille. Braille reading times were recorded for about half of those who read the selections in Braille. The mean reading rate for this group was about 57 wpm for the scientific material and 70 wpm for the literary material. (See Table IX)

Table IX

Means, Standard Deviations, and Average Word Rate Per Minute for Twenty-One Braille Readers

Type of Material	Mean in Min.	S.D.	WPM
Literature	30	9.5	70
Science	37	13.19	57

These results duplicate previous research findings (Ethington, 1956) and can be regarded as fairly representative for students at this

level. One may conclude, therefore, that blind school children may be presented material at a communication rate that is more than four times as fast as that of Braille reading with only a small loss in comprehension.

If, in the normal course of their education, the children had used recordings, they would have heard them at approximately 175 wpm. This would have been an improvement over Braille, but still would have been 100 wpm slower than the communication rate that the present study has shown to be effective.

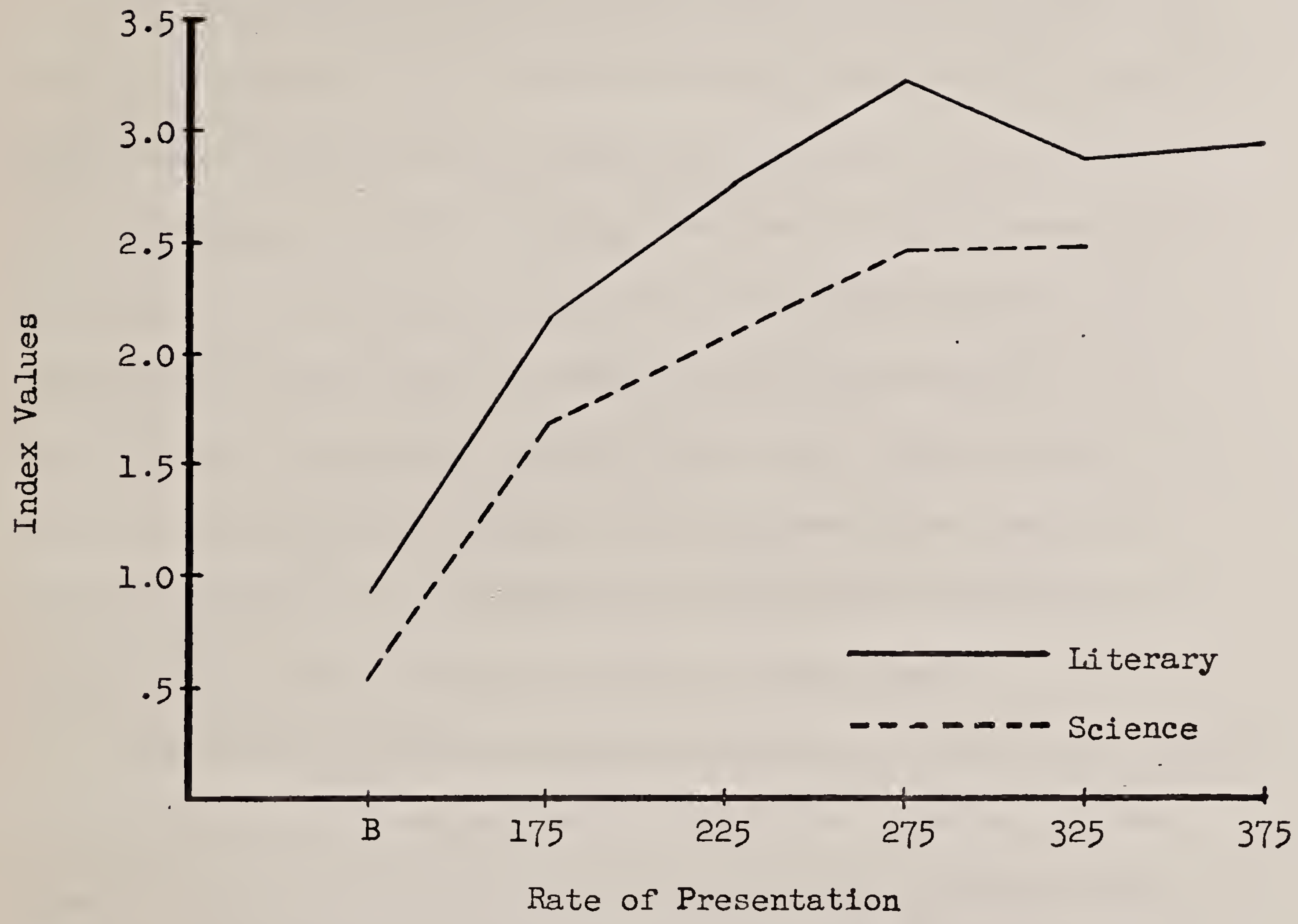
The subjects in the present study showed good comprehension of material presented at a rate that was somewhat faster than the median silent visual reading rate for seventh grade students of 215 words per minute. (Harris, 1947) This figure should be a reasonable estimate of the mean reading rate for the public school children used in establishing the reliabilities of the tests used in the present study. For purposes of comparison, the public school children were scored on the same 36 test items administered to those who listened at 275 wpm. The mean comprehension scores for the public school children were 14.88 for the scientific material and 24.81 for the literary material. The corresponding scores for those who listened at 275 wpm were 18.55 for the scientific material and 24.21 for the literary material. Thus we may tentatively conclude that information may be presented orally at a rate corresponding to the silent visual reading rate with equally good comprehension.

In order to evaluate the present findings one must consider

not only the amount learned, but also the time spent in learning. Suppose, for instance, that a child who listened to the material at 275 wpm instead of reading it in Braille learned half as much in one fourth the time. He could listen to the material a second time at the same rate and still save half the time spent in learning. As it turned out, the children who listened at 275 wpm comprehended very nearly as much as those who read the selections in Braille. Had they been permitted a second hearing, they may have shown much better comprehension than the Braille reading group and would have spent only half as much time learning. The relationship between the amount learned and the time spent in learning is shown graphically in Figure 2. (Page 19) The values in terms of which the curve in this Figure are plotted were obtained by dividing mean comprehension scores for each mode of presentation by the time required to present the material to that group. The resulting index numbers can be regarded as estimates of learning efficiency. Examination of these curves suggests that when the amount of time spent in learning is taken into account, those subjects who heard the materials at 325 wpm and at 375 wpm were learning more in a given amount of time than those who read the material in Braille. Thus what appears to be poor comprehension may be good comprehension when the reduced listening time is taken into account.

The implications of these findings for both education and research are clear. If the present results could not be improved upon, blind children would still be considerably ahead by

FIGURE 2



Comprehension as a Function of Presentation Time

listening to material at 275 wpm. They would have access to a communication rate comparable to that experienced by their sighted counterparts. However, it now seems likely that people can learn to understand material presented at faster rates. Research is needed to determine the upper limit in the comprehension of rapid speech and to develop efficient training procedures for achieving this upper limit.

Summary

Blind children depend upon the reading of Braille for most of the information they receive in their education. The blind high school student reads Braille at an average rate of about 90 words per minute. Blind children get some of their educational information by listening to records. A typical speaking rate for professionally trained readers is approximately 175 words per minute. The average sighted high school senior reads at a rate of 251 words per minute. It is apparent that the blind child is subject to a considerable educational handicap because of the very slow rate at which he must read.

One solution to this problem is the use of more rapid speech in presenting information orally. It is now possible, by the speech compression technique, to increase the word rate of a previously recorded selection by any desired amount without altering the voice of the speaker in pitch or timbre, and without changing the temporal relationships in his speech.

An experiment was conducted to determine the ability of 6th, 7th, and 8th grade Braille readers to understand rapid speech.

Two types of material, one literary and one scientific, were presented to the subjects in Braille and at 175, 225, 275, 375 words per minute. Comprehension of these materials was measured by multiple choice tests constructed for this purpose. The reliability was .86 for the science test and .91 for the literature test.

The data were treated by an analysis of variance of the factorial type with classification according to modes of presentation and types of material.

It was found that modes of presentation and types of material yielded significant overall variation, and there was a significant interaction between these two sources of variation. Comparison of mean comprehension scores for each of the listening groups with mean comprehension scores for the Braille readers indicated no significant loss in comprehension of the literary material up through 225 wpm at the 1% level of confidence. At faster word rates, 275, 325, 375 wpm, loss of comprehension was significant. There was no significant loss of comprehension through 275 wpm, for those who heard the scientific material.

It was felt that those losses in comprehension that were statistically significant were not all educationally important, especially when the time saved in presenting the materials was considered.

It was the opinion of the investigators that the usefulness of the speech compression technique was clearly demonstrated. We now know that blind school children can be given information

at a rate commensurate with that employed by normal children with no loss in comprehension. When, as a result of subsequent research, an efficient training program can be specified, blind children should be able to learn to understand rapid speech that is incomprehensible without training.

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Appendix A

Section I

Instructions for Braille Readers

This booklet contains a selection for you to read. Please read it very carefully, because when you have finished, you will be given a test to see how well you have understood it.

Read each question in the test booklet which you will receive later very carefully. Each question will be followed by four answers. Select from among the four answers the one you think is best. Take the pencil I have given you and draw a line through this answer.

There are two kinds of questions on the test. Here is an example of each.

First example:

Who was the first president of the United States?

a. George Washington
b. Benjamin Franklin
c. Alexander Hamilton
d. Patrick Henry

The answer is George Washington, so you would take your pencil and draw a line through this answer.

Second example:

Alexander Graham Bell invented:

a. the telegraph
b. the telephone
c. the cotton gin
d. the sewing machine

The answer is the telephone, so you would take your pencil and draw a line through this answer.

When I give you the signal turn to the next page in your booklet and start reading the selection.

Section II

Instructions for Those Who Listened at the Normal Rate

This is an experiment to find out how well you can listen. In a minute you will hear a selection over the tape recorder. Listen very carefully and try to remember as much of it as you can. When you have finished listening to the selection, you will be given a test that is written in Braille. The test is composed of multiple choice questions. Read each question very carefully. Each question is followed by four answers. Select from among the four answers the one you think is best. Then take the pencil I have given you and draw a line through this answer. There are two kinds of questions on the test. Here is an example of each.

First example:

Who was the first president of the United States?

a. George Washington
b. Benjamin Franklin
c. Alexander Hamilton
d. Patrick Henry

The answer is George Washington, so you would take your pencil and draw a line through this answer.

Second example:

Alexander Graham Bell invented:

a. the telegraph
b. the telephone
c. the cotton gin
d. the sewing machine

The answer is the telephone, so you would take your pencil and draw a line through this answer.

If you are ready to listen to the selection now, we will begin.

Section III

Instructions for Those Who Listened to Compressed Speech

This is an experiment to find out how well you can listen. In a minute you will hear a selection over the tape recorder. It may sound strange to you, but listen very carefully and try to remember as much of it as you can. Here is the way it will sound.

You are now listening to compressed speech. You are hearing words at a faster rate than the one to which you are accustomed. It may take you a little time to get used to it, but don't worry. Just do your best.

When you have finished listening to the selection, you will be given a test that is written in Braille. The test is composed of multiple choice questions. Read each question very carefully. Each question is followed by four answers. Select from among the four answers the one you think is best. Then take the pencil I have given you and draw a line through this answer. There are two kinds of questions on the test. Here is an example of each.

First example:

Who was the first president of the United States?

a. George Washington
b. Benjamin Franklin
c. Alexander Hamilton
d. Patrick Henry

The answer is George Washington, so you would take your pencil and draw a line through this answer.

Second example:

Alexander Graham Bell invented:

a. the telegraph
b. the telephone
c. the cotton gin
d. the sewing machine

The answer is the telephone, so you would take your pencil and draw a line through this answer. If you are ready to listen to the selection now, we will begin.

Appendix B

Test Items - Final Form

I Your Blood Transports Materials

1. What percent of the blood plasma is water?
   a. 45%
   b. 55%
   c. 75%
   d. 90%

2. What prevents the blood from moving back into the heart?
   a. the pericardium
   b. the valves
   c. Capillary expansion
   d. ameboid action

3. What is the sac-like membrane that covers the heart?
   a. the vena cava
   b. the aorta
   c. the pericardium
   d. the ventricle

4. We suspect a wound is infected if:
   a. Blood flowing from the wound clots
   b. Wound bleeds more than usual
   c. There is a surplus of red corpuscles in the wound
   d. The wound becomes surrounded by a red area and feels hot

5. White blood cells move:
   a. By floating wherever the liquid part of the blood takes them
   b. Until stopped by the narrow walls of capillaries
   c. By themselves
   d. In some parts of the body

6. What causes a wound to become infected?
   a. Loss of blood
   b. Clotting of blood platelets
   c. Engulfing of bacteria by white blood corpuscles
   d. Entrance of bacteria into the wound

7. Platelets are:
   a. Larger than red corpuscles but smaller than white corpuscles
   b. Larger than both red and white corpuscles
   c. Smaller than red corpuscles but larger than white corpuscles
   d. Smaller than both red and white corpuscles

8. The blood carries carbon dioxide to the lungs so that it may be:
   a. stored for future use
   b. eliminated
   c. combined with the oxygen that is breathed in
   d. used for respiration

9. The top of the heart is divided into how many cavities?
   a. 1
   b. 2
   c. 3
   d. 4

10. White blood cells are:
   a. Larger than red cells
   b. The same size as red cells
   c. Smaller than red cells
   d. Much smaller than red cells

11. The capillary walls are how many cells thick?
   a. One cell
   b. Two cells
   c. Three cells
   d. Four cells

12. What does blood transport?
   a. Waste to the body cells
   b. Oxygen and waste from the body cells
   c. Oxygen and food from the body cells
   d. Oxygen and food to the body cells

13. The liquid part of the blood transports to the lungs:
   a. Oxygen
   b. Carbohydrates
   c. Proteins
   d. Carbon dioxide

14. Why does blood flow through the lungs?
   a. To get air to white corpuscles and to get rid of bacteria
   b. To get rid of carbon dioxide and acquire oxygen
   c. To remove carbohydrates from the blood
   d. To remove platelets and waste material from the blood

15. Red blood cells move:
   a. In a direction opposite to that of the blood
   b. By floating wherever the liquid part of the blood takes them
   c. Until stopped by the narrow walls of capillaries
   d. By themselves

16. White blood cells keep the body alive by:
   a. Removing bacteria and dead body cells
   b. Carrying oxygen to the body cells
   c. Causing scar tissue to form over a wound
   d. Keeping the pus free of bacteria

17. What are the three pathways that blood follows in the body?
   a. Vessels, capillaries, and veins
   b. Arteries, veins, and tubes
   c. Arteries, capillaries, and veins
   d. Veins, vessels, and arteries

18. The heart:
    - a. pumps blood
    - b. purifies the blood
    - c. pumps and purifies blood
    - d. stores blood

19. The heart is:
    - a. a muscle
    - b. an enlarged artery
    - c. a membrane
    - d. a valve

20. What metal compound is found in the red blood corpuscles?
    - a. Tin
    - b. Iron
    - c. Lead
    - d. Copper

21. What are bacteria?
    - a. One celled animals
    - b. Disc-shaped platelets
    - c. One celled plants
    - d. Biconcave cells

22. In an artery how far does the blood flow per second?
    - a. 5" to 8"
    - b. 9" to 14"
    - c. 15" to 20"
    - d. 21" to 26"

23. Plasma is:
    - a. Another word for blood
    - b. The water that is found in blood
    - c. The liquid part of blood
    - d. The products of digestion

24. Pus is:
    - a. A fluid with a high concentration of corpuscles
    - b. Blood from which the hemoglobin has been removed
    - c. A fluid containing the waste products from the battle between white corpuscles and bacteria
    - d. A fluid used to keep wounds free of bacteria

25. Muscles in the walls of blood vessels:
    - a. Cause them to contract and expand
    - b. Help them bend when the body moves
    - c. Make their walls strong
    - d. Adjust their length when the body changes position

26. The blood in the heart moves from:
    a. one auricle to another
    b. one ventricle to another
    c. arteries to capillaries
    d. auricles to ventricles

27. How many chambers are there in the heart?
    a. 2
    b. 4
    c. 6
    d. 8

28. The walls of the auricles differ from the walls of the ventricles in what way?
    a. Thickness
    b. Wetness
    c. Smoothness
    d. Warmness

29. In the veins how far does the blood flow per second?
    a. 2"
    b. 3"
    c. 4"
    d. 5"

30. What does blood transport from body cells?
    a. Oxygen and food
    b. Oxygen
    c. Food materials
    d. Waste materials

31. About how many quarts of blood are in the body of a person who weighs 120 pounds?
    a. Two quarts
    b. $3\frac{1}{2}$ quarts
    c. Four quarts
    d. Six quarts

32. Why are the blood cells different in color?
    a. White blood cells contain hemoglobin
    b. Red blood cells do not contain an iron compound
    c. White blood cells contain an iron compound
    d. Red blood cells contain hemoglobin

33. Red blood cells keep the body alive by:
    a. Removing bacteria and dead body cells
    b. Carrying oxygen to the body cells
    c. Causing scar tissue to form over a wound
    d. Bringing an extra supply of blood to a wound

34. When you cut yourself, extra blood flows to the wound to:
    a. supply needed platelets and white corpuscles
    b. wash off the wound
    c. help form a protective scar for the wound
    d. permit hemoglobin to combine with the oxygen entering through the wound

35. The blood passes from:
    a. the auricles to the ventricles
    b. the ventricles to the auricles
    c. the auricles to the lungs
    d. from one ventricle to the other

36. The red blood cells:
    a. slope inward on both sides
    b. slope outwards on both sides
    c. are level and flat on both sides
    d. are level and flat on one side

II The Yellow Turtleneck Sweater

1. Harry's family proved their loyalty to him by:
   a. Wanting to drive him to school
   b. Protecting him from the stares of other students
   c. Going with him to see Mike
   d. Leaving the campus early

2. What town did Mike come from?
   a. New Haven
   b. Yorktown
   c. New York
   d. Newport

3. Who stopped the argument about the trip by saying that if Pa wants to drive we're driving?
   a. Harry
   b. Muriel
   c. Bobby
   d. Ma

4. How did the members of Harry's family feel about accompanying him?
   a. His brother did not want to go because he would miss a baseball game.
   b. His mother did not want to go because it would embarrass Harry, but would go to please his Father.
   c. His sister wanted to go because it would give her a chance to meet new boyfriends.
   d. None of the above

5. What argument did Harry's mother give for driving him to school?
   a. It was a short trip to school
   b. Harry had a lot of luggage
   c. They had bought a new car
   d. The weather was too bad.

6. What kind of a job did Harry have?
   a. He was a delivery boy at a drug store
   b. He was a clerk at a drug store
   c. He sold tickets at a theatre
   d. He was an usher at a theatre

7. What was the name of Harry's hometown?
   a. Fairville
   b. Fairfield
   c. Springfield
   d. Fairmont

8. Harry felt that no one thought he was grown up because:
   a. He was shy
   b. His mother protected him too much
   c. He had never been away from home alone
   d. He was smaller and thinner than most people his age.

9. Mike told Ma he would be on the campus:
    a. Thursday
    b. Friday
    c. Saturday
    d. Sunday

10. When Mike greeted Harry he:
    a. Ignored him
    b. Stared at him
    c. Slapped him on the back
    d. Gave him such a warm greeting that it was embarassing

11. What year in school was Mike?
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior

12. Where did Harry's family wait for him while he put on his sweater?
    a. Outside the entrance to the dormitory
    b. On benches under the trees of the campus
    c. In the car
    d. In Mike's room

13. What argument did Harry give for going to the school alone?
    a. If I'm old enough to go I'm old enough to get there alone
    b. You have planned the trip without my knowing it
    c. I can never go any place by myself
    d. I don't want my little sister tagging along.

14. As far as Harry was concerned what did a young man have to be to go to the new school?
    a. real smart
    b. independent
    c. friendly
    d. wealthy

15. Harry thought that when he went away to school:
    a. He should become more independent of his family
    b. His family should take more interest in him
    c. He should not be expected to associate with his brother and sister
    d. He thought his family would not be capable of understanding his college life.

16. What argument did Harry's father give for driving him to school?
    a. the bad weather
    b. the new car
    c. the long trip
    d. the dangerous drive

17. Who finally made the decision to turn in the railroad ticket and drive to school?
    a. Pa
    b. Ma
    c. Harry
    d. Muriel

18. Who was Mike?
    a. Harry's brother
    b. Harry's cousin
    c. The boyfriend of Harry's sister
    d. A friend of Harry's father

19. Harry bought the sweater so that he could:
    a. Impress his family
    b. Impress the other students
    c. Dress differently than other students
    d. Impress Mike

20. Before the family could enter the dormitory they had to get:
    a. Directions
    b. Permission slips
    c. A key
    d. A guide

21. Harry discouraged the plan to look up Mike because:
    a. He did not want to be seen walking across the campus with his family.
    b. He was afraid it would take so much time that his father would have to drive home in the dark.
    c. He did not want his mother to become too tired.
    d. He didn't think Mike could be found.

22. Harry's room was in:
    a. Washington Hall
    b. Harkness Hall
    c. Wesley Hall
    d. Welch Hall

23. In discussing whether or not Harry's family would go with him to school his mother said:
    a. Your father's word is law
    b. You'll have to make up your own mind
    c. Your parents know best
    d. You can go alone next time

24. What was the accepted dress at the school Harry entered?
    a. Turtleneck sweater
    b. Plaid jacket with tie
    c. Tweed jacket with tie
    d. White jacket without tie

25. About how much time was required to drive from Harry's home to the school?
    a. One hour
    b. Two hours
    c. Three hours
    d. Four hours

26. Harry's father wanted to drive him to school because:
    a. He had never been to the school
    b. He had recently bought a new car
    c. He was afraid Harry might get off to a bad start
    d. He wanted to share this important event in his son's life.

27. How old were Harry's brother and sister in relation to him?
    a. His brother was younger and his sister was older
    b. His sister was younger and his brother was older
    c. Both his brother and his sister were older
    d. Both his brother and sister were younger

28. When Harry returned to his room after visiting Mike he:
    a. Talked nervously
    b. Changed clothes
    c. Discussed new drapes with his mother
    d. Stood around waiting for his parents to leave

29. Harry attracted attention while walking across the campus because:
    a. His family was with him
    b. He was walking so fast
    c. Of the sweater he was wearing
    d. He was so thin and small

30. When did Harry realize that his sweater would not be acceptable?
    a. At Harkness tower
    b. In Mike's room
    c. In Welch Hall
    d. While walking about the campus with his family

31. What item did Harry's mother suggest to improve his room?
    a. A new desk
    b. Bright green carpets
    c. A new bureau
    d. Draperies

32. Harry thought that a boy who is taken to school by his family:
    a. Ends up marrying a girl
    b. Is popular
    c. Is called a drip
    d. Is the brainy type

33. What year of school was Harry starting?
    a. Freshman in high school
    b. Sophomore in high school
    c. Freshman in college
    d. Sophomore in college

34. Who actually influenced Harry into going with the family to school?
    - a. His father
    - b. His brother and sister
    - c. His mother
    - d. His cousin Mike

35. Who sat in the back seat of the car on the way to school?
    - a. Harry, his brother, and his sister
    - b. Harry's brother, sister, and mother
    - c. Harry, his mother, and his sister
    - d. Harry's mother, father and sister

36. What was the name of Harry's brother?
    - a. Buddy
    - b. John
    - c. Henry
    - d. Bobby

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